Parkland Lead Study: 2002

Final Report on

Analysis of Health Survey Data

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Parkland Lead (Pb) Health Screening Project: Analysis of Phase II Survey Data

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Abstract

Background: Lead smelters operated in Dallas, Texas from the 1930's to 1990.

Objective: The objective of this investigation was to analyze data collected during a health screening survey conducted by Parkland Health & Hospital System initiated in September 2002.

Subjects: Subjects: Survey participants were individuals age from 3 months year old to 89 years of age who were current or past residents of neighborhoods locally known as West Dallas and Cadillac Heights (Zip Codes 75208, 75211, 75212, 75247, 75203, 75215, and 75216).

Materials and Methods: The sample was a sample of convenience, with participants "self-selecting" whether or not to participate. No sampling design was employed in the survey. The survey was conducted in two phases. Phase I was a paper and pencil survey of health status and history using non-standardized, non-normalized questionnaires developed in-house by Parkland staff. Phase II was a second visit by participants with no sampling design employed, comprising a sample of convenience with participants self-selecting whether or not to participate. The cleansed phase I data included 4,183 individuals (1,628 males, 2,555 females). Cleansed phase II data was comprised of 2,347 individuals (903 males, 1,444 females). Blacks from the National Health and Nutritional Survey (NHANES) III survey (1999) were available from the National Center for Health Statistics. Blacks (age less than 1 year old to more than 80 years of age) were extracted from the national survey, and only Texas residents (Dallas, El Paso, Tarrant, and Harris Counties) were used in the final comparisons. Stepwise logistic regression was used to analyze laboratory data, cancer prevalence, and birth defect incidence

Results: Among adult (ages 20 to 80+ years) males and females, blood lead levels were lower than age-group matched comparison Texas Blacks from NHANES III. Among children (ages less than one year to 19 years), blood lead levels from the 2002 survey were lower than age-group matched comparison Texas Black children from the NHANES III survey. Importantly, age-group specific child blood lead levels in the 2002 Parkland survey were one-tenth the blood lead levels observed in age-group matched 1980-1989 children from the data gathered by the present investigator in a prior investigation. Brain cancer was possibly associated with having a parent who worked in the smelter. The following birth defects were possibly associated with lead exposure: brain plus spine, brain, and alimentary tract.

Conclusions: Lead pollution in the West Dallas and Cadillac Heights communities was a health problem previously recognized (e.g., 1980's and before). Blood lead levels of all age groups 19 years and younger (the populations segment well-known to be a barometer of human public/community health conditions) decreased by ten-fold comparing 2002 data with 1980-1989 data. Clean-up and abatement efforts subsequent to designation as an EPA Superfund site in the mid-1990's have markedly reduced the lead pollution health threat to children and adults in the target neighborhoods. These results are tentative and it is recommended that medical records for the cancer and birth defect clusters be reviewed.

1 Introduction to Lead (Pb) and Human Health Effects

1.1 Introduction to Lead (Pb) and Human Health Effects

Lead poses several toxic threats to humans because it mimics essential human elements and trace elements such as iron, calcium, zinc, and copper. Exposure to lead during child growth and development is particularly vulnerable to adverse effects such as physical growth and mental retardation, and behavioral abnormalities.

Elemental lead and inorganic lead compounds are absorbed orally or by inhalation. Also, organic lead (e.g., tetraethyl lead from gasoline) is absorbed to a significant degree through the skin. Adults absorb only about 10 to 20 percent of lead ingested, but children absorb almost 50 percent of lead ingested. Gastrointestinal lead absorption is enhanced by malnutrition, intentional fasting, and nutrient deficiencies (calcium, iron, and zinc). Lead sulfide, commonly found in mining waste, is an exception to the toxicokinetics described above; its absorption is minimal.

Lead toxicity is probably related to its affinity for cell membranes and mitochondria. This interaction interferes with mitochondrial oxidative phosphorylation and adenosine triphosphate (ATP) action on essential trace metals (sodium, potassium, calcium). Lead impairs the activity of calcium-dependent intracellular messenging and brain protein kinase C are also impaired. Recent molecular genetic analysis suggests that lead catalyzes inclusion body formation, which may translocate the metal into cell nuclei and alter gene expression.

Following ingestion, lead enters blood plasma, and it equilibrates rapidly with extracellular fluid. It crosses membranes (e.g., blood-brain barrier, placenta), accumulating in soft and hard tissues. Approximately 95 to 99 percent of lead is bound to red cells, where hemoglobin is the prime site. Hence, lead is usually measured in whole blood. Most lead that is absorbed competes for calcium binding sites, and is largely incorporated into the skeleton where 90 percent of the body's total lead burden is sequestered. Lead excretion is mainly through urination and defecation. In addition, lead is also deposited in hair and nails, and voided through sweat, saliva, and breast milk. The half-life of lead in blood is approximately 25 days, based upon direct human experimentation using adult male volunteers. In soft tissue, lead’s half-life ($T^{1/2}$) is about 40 days. Lead remains in non-labile bone for more than 25 years. Thus, blood lead levels may decline significantly while the body's total burden of lead remains heavy.

1.2 Lead Toxicity in Adults

Symptomatic lead poisoning in adults usually develops when blood lead levels exceed 70 µg/dL for a period of weeks. Patients with elevated lead present with clinical symptoms characterized by abdominal pain, headache, irritability, joint pain, fatigue, anemia, peripheral motor neuropathy, and deficits in short-term memory and concentration. Encephalopathy is rare. A "lead line" sometimes appears at the gingiva-tooth interface following prolonged high-level exposure. There is considerable variation in symptomology with some individuals presenting with these clinical signs and symptoms at lower blood lead levels (40 to 70 µg/dL) and/or with acute periods of exposure. Chronic subclinical lead exposure is associated with interstitial nephritis, tubular damage (with tubular inclusions), hyperuricemia (with an increased risk of gout), and a decline in glomerular filtration rate and chronic renal failure. Epidemiological studies suggest that blood lead levels in the range of 7 to 35 µg/dL are associated with increased blood pressure, decreased creatinine clearance, and cognitive performance deficits that are too subtle for clinical detection for causal attribution to lead exposure but nevertheless may contribute significantly to the causation of chronic disease (e.g., kidney failure, cardiovascular disease associated with hypertension, etc).

1.3 Lead Toxicity in Children

Symptomatic childhood lead poisoning usually develops at blood lead levels that exceed 80 µg/dL. Typical clinical symptoms include abdominal pain, irritability, lethargy, anorexia, pallor (resulting from anemia), ataxia, and slurred speech. In advanced cases, convulsions, coma, and death may occur, caused by cerebral edema and renal failure occurs. Subclinical lead poisoning (Pb < 30 µg/dL) can cause mental retardation and deficits in language, cognitive function, balance, behavior, and school performance, even in the absence of other clinical symptoms. The general consensus of studies of the effects lead on child intellectual function and development is that deficits are induced. Data indicate that cognition is probably impaired in a dose-related fashion at blood lead levels well below 30 µg/dL. No threshold for this effect is known to exist below which no deficits are observed. The lowest measurable blood lead level is 1 µg/dL, and most authorities claim there is no safe blood lead level during childhood. Importantly, negative impact on child physical growth and mental development is greatest when: (1) exposure duration is long, and (2) children are young (2 years of age and younger).

1.4 Additional Concerns for Children and Adults

Children and adults are vulnerable to the adverse effects of lead accumulated in bone. Lead deposited in bone can pose a threat later in life, particularly at times of increased bone remodeling and resorption such as: (1) child physical growth,

(2) pregnancy, (3) lactation, (4) calcium deficiency, and (5) osteoporosis. High bone lead levels are also a risk factor for anemia and hypertension. Hyperthyroidism has been reported to cause lead toxicity in adults by mobilizing stores of bone lead acquired during childhood, but this is more speculative than clinical fact.

1.5 Purpose of Current Investigation

The purpose of the current investigation was to analyze data collected on adults and children in a health survey by Parkland Health and Hospital Systems in communities where lead smelters had operated (West Dallas and Cadillac Heights) in Dallas, Texas from 1936 to 1990. The City of Dallas Health Department had recognized that lead from the smelters posed a serious health hazard to the surrounding communities, and conducted blood lead and environment screenings as early as 1966, a decade before the Centers for Diseases Control (CDC) published blood lead level recommendations (Little et al., 1990). In the early 1990's, the US Environmental Protection Agency (EPA) designated this area as a Superfund site, and conducted a major cleanup operation, removing the top eight to then inches of soil from the neighborhood.

2 Study Subjects, Materials, and Methods

Survey participants were individuals age from 3 months old to 89 years of age who were current or past residents of neighborhoods where smelters were located locally known as West Dallas and Cadillac Heights (Zip Codes 75208, 75211, 75212, 75247, 75203, 75215, and 75216).

2.1 Parkland Human Subjects Institutional Review Board

Parkland Health & Hospital System submitted the protocol to the UT Southwestern Medical Center Institutional Review Board, which approved the survey for Use of Human Subjects. All participants gave written informed consent to participate in the survey, or were assented by their legal guardian.

2.2 Sample of Convenience for Health Screening; No Research Design

The sample was a sample of convenience, with participants "self-selecting" whether or not to participate. No sampling design was employed in the survey.

2.3 Survey Conducted in 2002 in Two Phases

The survey was conducted in two phases. Phase I was a paper and pencil survey of health status and history using non-standardized, non-normalized questionnaires developed in-house by Parkland staff. Phase II was a second visit by participants with no sampling design employed. All phase I participants were invited to participate in phase II, comprising a sample of convenience with participants self-selecting whether or not to participate.

2.4 Databases from Phase I and II Joined

Data were provided to the present investigator in the form of two Microsoft Access databases that contained no metadata or data dictionaries. Participant ID, name, and Social Security Number related the databases. These were used as relational keys. The first database contained survey data from 4,215 respondents, and the second database contained laboratory and physical examination information for 2,797 participants. Data were audited for obvious and logical data errors, and cleansed. Cleansing was comprised of reviewing data for errors and correcting those for which the correct value could be deduced (e.g., F for female was often coded as f; f was converted to F). Where a correction was not possible, the data were recoded as missing values. Another example of cleansing was, where age was missing but date of birth was available, age was computed.

The cleansed phase I data included 4,183 individuals (1,628 males, 2,555 females) (Table 1). Cleansed phase II data was comprised of 2,347 individuals (903 males, 1,444 females) (Table 2). Aggregate age categories were formed in five-year intervals (e.g., ages 20 to 24 years were combined) to enhance samples sizes available for comparison. Two comparison groups were constructed for the analysis.

2.5 Comparison with Texas Blacks from NHANES III

Individual health data for Blacks from the National Health and Nutritional Survey (NHANES) III survey (1999) were available from the National Center for Health Statistics. Blacks (age less than 1 year old to more than 80 years of age) were extracted from the national survey, and only Texas residents (Dallas, El Paso, Tarrant, and Harris Counties) were used in the final comparisons.

2.6 Comparison with Children in Smelter Communities in 1980-1989

During the 1980’s (1980-1989) the present investigator studied blood lead levels among children in the target communities, and was able to use data from that time period for secular comparison with the 2002 health survey. (Little et al., 1990).

2.7 Listwise Deletion of Missing Data and Other Exclusions

Listwise deletion of data for missing values for all analyses was employed.

2.8 Data Modeling and Transformation

Data were modeled according to data type, and logical rules constructed for their relations to other variables. One variable, Body Mass Index (BMI) was computed: BMI = Weight (kg) / Height (meters).^{2} Data were modeled for binary dependent variables, and independents were modeled according to their available data types.

2.9 Analytical Methodology

Stepwise logistic regression was used to analyze laboratory data, cancer prevalence, and birth defect incidence. SAS Enterprise Data Warehouse was used to construct metadata and data models, and SAS Enterprise Miner was used for data integrity assessment. Significance level was $P < 0.05$ for inclusion in this report. Bonferroni corrected P values for maximum protection against Type I Statistical Error was: (1) Lab tests – $P < 0.001$; (2) cancers – $P < 0.01$; and (3) birth defects – $P < 0.005$.

2.10 Software Tools Employed

SAS software (SAS Institute, Cary, NC, Version. 8.2, and Enterprise Miner v 4.0 © 2004) was employed for all data treatment and analyses.

3 Analytical Results

3.1 Adult Blood Lead: Descriptive Comparisons

Among adult (ages 20 to 80+ years) males (Table 3) and females (Table 4), blood lead levels were lower than age-group matched comparison Texas Blacks from NHANES III. However, blood lead levels were not clinically significantly different between survey participants who were current vs. past residents.

3.2 Child Blood Lead: Secular Change Comparisons

Among children (ages less than one year to 19 years), blood lead levels from the 2002 survey were lower than age-group matched comparison Texas Black children from the NHANES III survey (Table 5). Importantly, age-group specific child blood lead levels in the 2002 Parkland survey were one-tenth the blood lead levels observed in age-group matched 1980-1989 children from the data gathered by the present investigator in a prior investigation ($P < 0.0001$) (Little et al., 1990).

3.3 Liver Function panel

Stepwise logistic regressions indicated that the liver function panel tests were mainly affected by increasing age and abnormally high BMI. Abnormal Alkaline Phosphatase was the only liver test significantly associated with blood lead level (Table 6).

3.3.1 Liver Function: Clinical Impression

Logistic regression analysis of clinically assessed abnormal liver function was significantly associated with lower age, male gender, and abnormal Gamma-glutamyl Transpeptidase (GGT) or (GGTP).

3.3.2 Aspartate Aminotransferase (AST)

AST is usually used to detect liver damage, and its levels are also compared with other liver enzymes levels (alkaline phosphatase (ALP), and alanine aminotransferase (ALT)) to determine type of liver disease.

Abnormal AST level was significantly associated with abnormally high BMI and tobacco smoking.

3.3.3 Alkaline Phosphatase (ALK P)

In the presence of liver disease, elevated ALP levels may indicate blocked bile ducts.

Abnormally high ALK P was significantly associated with younger age and blood lead level.

3.3.4 Total Bilirubin

Elevated bilirubin often signals that red cells are being destroyed in excess, or that the liver is incapable of removing bilirubin from the blood.

Abnormally high bilirubin was significantly associated with gender; males were almost eight fold more likely than females to have elevated bilirubin.

3.3.5 Alanine Aminotransferase (ALT)

ALT is another test to detect liver injury, and its values are usually compared to the levels of other enzymes (ALP, AST) help diagnose the form of liver disease is present.

Abnormal ALT was significantly associated with normal BMI, and tobacco smoking.

3.3.6 Gamma-glutamyl Transpeptidase (GGT)

The GGT test is used to detect liver and bile duct injury. GGT (elevated in about 75% of chronic drinkers) is sometimes used to screen for chronic alcohol abuse. However, other drug abuse (cocaine, heroin, amphetamine), medical drug use (ranitidine, statin-drugs) and exposure to some toxicants (lead (Pb) and phosphate-based anticholinesterase insecticides) are associated with elevated GGT.

Abnormal GGT was significantly associated with advanced age, male gender, and tobacco smoking.

3.4 Blood Chemistry Panel Total Blood Cell Count

The blood chemistry panel is a broad diagnostic tool that is used to detect anemia, infections and toxic exposures (Table 7).

3.4.1 Red Blood Cell Count (RBC)

Red blood cell (RBC) count is a count of the actual number of red blood cells per volume of blood.

No variables in the analysis were significantly associated with RBC, or Blood Cell Count.

3.4.2 White Blood Cell Count (WBC)

White blood cell (WBC) count is a count of the actual number of white blood cells per volume of blood.

Abnormal WBC was associated with increases in blood lead level and male gender.

3.4.3 Hemoglobin (HGB)

Hemoglobin measures the amount of oxygen-carrying protein in the blood.

Abnormal HGB was significantly associated with younger age, female gender, and NOT smoking tobacco.

3.4.4 Hematocrit (HCT)

Hematocrit measures the amount of space red blood cells take up in the blood. It is reported as a percentage.

Abnormal HCT was significantly associated with advanced chronological age.

3.4.4 Platelets (PLT)

The platelet count is the number of platelets in a given volume of blood.

Abnormal PLT was significantly associated with BMI that tended to NOT be abnormally high.

3.4.5 Mean Corpuscular Hemoglobin (MCH)

Mean corpuscular hemoglobin (MCH) is a calculation of the amount of oxygen-carrying hemoglobin inside RBCs. Macrocytic RBCs are larger than other RBCs, and also tend to have higher MCH values.

Abnormal MCH was significantly associated with current residence (in the smelter neighborhoods, or outside), with those living outside tending to have normal MCH values.

3.4.6 Mean Corpuscular Hemoglobin Concentration (MCHC)

Mean corpuscular hemoglobin concentration (MCHC) is percentage of hemoglobin in the RBCs. Decreased values point to decreased oxygen-carrying capacity because of decreased hemoglobin inside the cell (hypochromasia). Hypochromasia is characteristic of iron deficiency anemia and in thalassemia.

Abnormal MCHC was significantly associated with advancing age, female gender, and not smoking tobacco.

3.4.7 Red Cell Distribution Width Coefficient of Variation (RDW) or (RDW CV)

Red cell distribution width (RDW) measures variation in the size of RBCs. In some anaemias (e.g., pernicious anemia) the amount of variation (anisocytosis) in RBC size (along with variation in shape – poikilocytosis) may help assess severity.

Abnormal RDW was significantly associated with advancing age.

3.4.8 Mean Platelet Volume (MPV)

Mean platelet volume (MPV) is a measure of platelet average size. New platelets are larger, and an increased MPV occurs when increased numbers of platelets are being produced.

No variables in the analysis were significantly associated with abnormal MPV.

3.5 Physical Examination And Renal Function

Physician evaluated neurological examination, blood pressure, and kidney function (including creatinine and uric acid lab tests) were analyzed for association with lead exposure and other parameters (Table 8).

3.5.1 Neurological Examination

Physician’s impression of whether or not the standard physical examination indicated any neurological abnormalities.

Abnormal neurological examination was significantly associated with advancing age.

3.5.2 Blood Pressure

Physician’s clinical impression of whether or not the patient’s blood pressure was elevated based upon systolic and diastolic pressures and pulse.

Abnormal blood pressure was associated with advancing chronological age, male gender, and abnormally high BMI.

3.5.3 Kidney Function, Clinical Impression

Physician’s clinical evaluation of whether or not the patient’s kidney function was abnormal based upon laboratory tests, including the kidney panel, creatinine, and uric acid.

Abnormal kidney function was associated with advancing age, male gender, and not smoking tobacco.

3.5.4 Creatinine

Creatinine is used to determine whether kidney function is normal (low blood creatinine) and able to filter small molecules such as creatinine from blood.

Abnormal creatinine was associated with higher blood lead levels, male gender, and not smoking tobacco.

3.5.5 Uric Acid

The uric acid test is used to determine whether the body is breaking down cells too rapidly or purging uric acid too slowly. High levels of uric acid are associated with pain in toes and/or joints (gout). Gout is an inherited disorder that affects purine metabolism, but may be associated with kidney failure.

Abnormal uric acid was significantly associated with having an abnormally high BMI and with being a current resident of one of the communities in which lead smelters operated.

3.6 Blood Lipid Panel

The blood lipid panel is used to assess a patient's risk of developing cardiovascular diseases related to fatty streak depositions, and eventual plaque formations that lead eventually to arterial obstruction (i.e., heart disease). Cholesterol is different from most tests in that it is not used to diagnose or monitor a disease but is used to estimate risk of developing a disease — specifically coronary artery disease.

3.6.1 Total Cholesterol

High blood cholesterol is associated with hardening of the arteries, heart disease and a raised risk of death from heart attacks; cholesterol testing is considered a routine part of preventive health care.

Abnormal total cholesterol was significantly associated with advancing age and abnormally high BMI (Table 9).

3.6.2 Low Density Lipoprotein (LDL)

LDL or "bad cholesterol" is used to predict the risk of developing coronary artery disease. LDL cholesterol is considered the most important form of lipids in determining the risk of heart disease. Treatment decisions are usually based upon LDL laboratory tests.

Abnormal LDL was significantly associated with advancing age, male gender, and abnormally high BMI.

3.6.3 Triglycerides

Blood tests for triglycerides are a lipid profile also used to identify the risk of developing heart disease. Diabetics are especially prone to have elevated triglycerides because trigylcerides increase markedly when blood sugar is dangerously elevated.

Abnormal triglycerides were not significantly associated with any of the variables include in the health survey in logistic regression analysis.

3.6.4 High Density Lipoproteins (HDL)

Abnormal HDL cholesterol is another test used to estimate the risk of developing heart disease. If a high total cholesterol test value is due mostly to high HDL, the patient is usually considered to be at low risk for heart disease.

HDL was significantly associated with increased blood lead.

3.6.5 HDL-Total Cholesterol Ratio

If HDL is 20% of the total cholesterol, the risk of heart disease is average. If HDL is more than 20% of the total cholesterol, risk of heart disease is less than average. This is usually expressed as a ratio of cholesterol to HDL. It is desirable for the cholesterol/HDL ratio to be less than 5. Ratios outside this range are abnormal.

Abnormal cholesterol ratio was significantly associated with male gender and abnormally high BMI.

3.7 Diabetes Panel

An oral glucose tolerance test (OGTT / GTT) may be used to diagnose diabetes and pre-diabetes. However, the American Diabetes Association recommends two tests (either the fasting glucose or the OGTT) be done at different times in order to confirm the diagnosis. The OGTT involves a fasting glucose, followed by the patient drinking a standard amount of a glucose solution to "challenge" their system, followed by another glucose test two hours later. Alternatives include blood glucose level and the hemoglobin A1C marker.

3.7.1 Glucose

The glucose test is a snapshot, a point in time of a rapidly changing condition. It tells what the blood glucose level was at the moment it was collected. The fasting blood glucose level (collected after an 8 to 10 hr fast) is used to screen for and diagnose diabetes and pre-diabetes.

Abnormal glucose was significantly associated with advancing age and an abnormally high BMI (Table 10).

3.7.2 Hb A1C Marker

The Hb A1C marker indicates the level of diabetes control over the last few months. A1C will reflect the average amount of glucose in blood over a long time period (several months).

Abnormal A1C was significantly associated with advancing age and an abnormally high BMI.

3.8 Cancer Frequencies

From meta-analysis of existing data in the published literature, it was concluded that: "There is only weak evidence associating lead with cancer [in humans]; the most likely candidates are lung cancer, stomach cancer, and gliomas" (Steenland and Bofetta, 2000). However, a recent report from Sweden associated a higher risk of meningioma with occupational exposure to lead (Navas-Acien et al., 2002). For all cancer sites combined, cancer death rates among African Americans are higher than other racial or ethnic populations in the US (Ries et al., 2000). As mentioned, three cancers (lung, stomach, gliomas/meningiomas) appear increased among those exposed occupationally to lead (Table 11). This analysis does not consider population background rates. It is a simple stepwise multivariate logistic regression analysis of the odds within the sample of disease occurrence based upon self-reported data.

3.8.1 Any Cancer

Self-reported cancer at any site was significantly associated with advancing age.

3.8.2 Brain Cancer

Self-reported brain cancer was significantly associated with having a parent who worked in one of the lead smelters.

3.8.3 Leukemia ("Blood Cancers")

No variables were significantly associated with "blood cancers."

3.8.4 Lung Cancer

Self-reported lung cancer was significantly associated with advancing age, and was strongly associated with tobacco smoking.

3.8.5 Alimentary Tract Cancers

No variables were significantly associated with alimentary tract cancers.

3.9 Birth Defects

The data provided on birth defects analyzed here was self-report by a parous female. Other reports by fathers, for example, was excluded for biological plausibility reasons (Table 12).

3.9.1 Brain And Spine Defect

Brain Plus Spine defects were significantly associated with having a parent who worked in one of the smelters.

3.9.2 Spinal Defect

No variables were significantly associated with spine defects.

3.9.3 Cleft Lip and/or Palate

No variables were significantly associated with Cleft Lip and/or Palate.

3.9.4 Heart Defect

Heart defects were borderline associated with the mother working in one of the smelters ($P < 0.06$).

3.9.5 Lung Defect

Lung defects were significantly associated with advancing age.

3.9.6 Alimentary Tract Defects

Stomach-intestinal tract defects were significantly associated with advancing maternal age and having a parent who worked in one of the smelters.

3.9.7 Genitourinary Defect

Genitourinary defects were significantly associated with increasing maternal age, and with not currently being a resident in West Dallas or Cadillac Heights.

3.9.8 Skeletal-Muscular Defect

No variables were significantly associated with skeletal-muscular defects.

3.9.9 Down Syndrome

No variables were significantly associated with Down syndrome.

3.9.10 Other Chromosomal Defect

Other chromosomal defects were significantly associated with a relative of the mother working in a smelter. As noted in Table 12, this is not a biologically reasonable result, and is probably a spurious association.

3.10 Adult BMI Comparisons

Black adults that participated in Phase I of the survey were compared to NHANES III data. The comparison is qualitative because clinical significance, not statistical is the objective (Tables 13 and 14).

3.10.1 Male BMI and NHANES Comparison

Dallas adult Black males from the survey were more obese by BMI than NHANES III Texas Black males at all ages except for the groups 75-79 years and 80-89 years old (Table 13).

3.10.2 Female BMI and NHANES Comparison

Dallas adult Black females from the survey were more obese by BMI than NHANES III Texas Black females at all ages except for the group 80-89 years (Table 14).

4 Summary

In summary, lead exposure in the year 2002 seems not to be a major public health problem in West Dallas and Cadillac Heights where the smelters formerly operated. This can be directly attributed to the EPA Superfund Cleanup that was done in the early 1990's. Prior to the Superfund Cleanup, lead was a health hazard as shown in the blood lead values of children. Among adult (ages 20 to 80+ years) males and females, blood lead levels were lower than age-group matched comparison Texas Blacks from NHANES III. Among children (ages less than one year to 19 years), blood lead levels from the 2002 survey were lower than age-group matched comparison Texas Black children from the NHANES III survey. Importantly, age-group specific child blood lead levels in the 2002 Parkland survey were one-tenth the blood lead levels observed in age-group matched 1980-1989 children from the data gathered by the present investigator in a prior investigation (Little et al., 1990).

Stepwise logistic regression indicated that: (1) liver function panels were mainly affected by increasing age and abnormally high BMI; with abnormal Alkaline Phosphatase being the only liver test significantly associated with blood lead level; (2) hematology panel was affected significantly by advancing age, high BMI, and tobacco smoking, with only abnormal WBC being significantly associated with blood lead level; (3) kidney function was not directly associated with blood lead level, but abnormal creatinine was significantly associated with blood lead level; (4) the blood lipid panel was significantly associated with increasing age and abnormally high BMI, and abnormally high LDL was associated with blood lead level; (5) diabetes related tests were only associated with advancing age and abnormally high BMI.

Self-reported cancers were analyzed in the same fashion, and three findings emerged: (1) self-reported presence of any cancer was associated with increasing age, (2) self-reported brain cancer was associated with having had a parent who worked in the smelter (OR = 6.6), and (3) self-reported lung cancer was associated with tobacco smoking (OR = 7.0).

Analysis of birth defects (polling only parous women, excluding males and children from list of respondents) revealed several interesting associations: (1) brain plus spine defects were significantly associated with whether or not the mother's parent worked in the smelter (OR = 20); (2) brain defects were significantly associated with whether or not the mother (respondent) worked in smelter (OR = 27); (3) heart defects were borderline significantly ($P < 0.06$) associated with whether or not the mother (respondent) worked in a smelter; (4) alimentary tract defects were significantly associated the mother having worked in a smelter (OR = 3.9); (5) genitourinary defects were significantly associated with the mother (respondent) not currently lived in the target area (Zip Codes 75208, 75211, 75212, 75247, 75203, 75215, and 75216).

In conclusion, lead pollution in the West Dallas and Cadillac Heights communities was a health problem previously recognized (e.g., 1980's and before). Blood lead levels of all age groups 19 years and younger (the populations segment well-known to be a barometer of human public/community health conditions) decreased by ten-fold comparing 2002 data with 1980-1989 data. Clean-up and abatement efforts subsequent to designation as an EPA Superfund site in the mid-1990's have markedly reduced the lead pollution health threat to children and adults in the target neighborhoods. Liver function was weakly affected by blood lead level, but highly affected by heightened liver activity of a specific enzyme (GGTP) frequently associated with alcohol abuse, cocaine use, or exposure to other toxicants (e.g., lead exposure). Additionally, abnormal kidney function among older adults who lived in these neighborhoods was associated with a lingering effect of previous lead exposure. Contemporary major health hazards in the target area in which health interventions may have a meaningful affect are (1) obesity, (2) smoking and (3) alcohol use or exposure to other toxicants in an aging population. Obesity and its attendant chronic disease outcomes (e.g., diabetes) with advancing age are the major causes of morbidity identified by analysis of data from the 2002 in the contemporary residents of West Dallas and Cadillac Heights.

These results are tentative and it is recommended that medical records for the cancer and birth defect clusters be reviewed.